Megger

TDR1000/3
TDR1000/3P
CFL510G
TDR500/3

Time Domain Reflectometers

User Manual

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⚠ SAFETY WARNINGS

- Safety warnings and precautions must be read and understood before the instrument is used. All Safety warnings and precautions must be observed during use.
- The circuit under test must be switched off, de-energised, securely isolated and proved safe before test connections are made.
- Use the correct lead set. On power systems the Megger fused lead set must be used. Refer to the Test Lead selection page in this user guide to identify the correct lead set.
- The operator must verify that the circuit is safe before testing and take the appropriate precautions.
- Ensure that hands remain behind guards of probes/clips when testing.
- The instrument should not be used if any part of it is damaged. Also all test leads, probes and crocodile clips must be in good order, clean and with no broken or cracked insulation.
- Disconnect the test leads before removing the battery cover. The battery cover must be in place whilst conducting tests.
- This product contains no user service parts.
- All relevant safety procedures must be followed.

THE INSTRUMENT MUST ONLY BE USED BY SUITABLY TRAINED AND COMPETENT PERSONS

Symbols

The following symbols are used on this instrument

CAUTION: RISK OF DANGER

EQUIPMENT PROTECTED THROUGHOUT BY DOUBLE INSULATION OR REINFORCED INSULATION

EQUIPMENT COMPLIES WITH RELEVANT EU DIRECTIVES

EQUIPMENT COMPLIES WITH AUSTRALIAN EMC REQUIREMENTS (C-tick) (NOT FOR SAFETY)

THIS EQUIPMENT SHOULD BE RECYCLED AS ELECTRONIC WASTE

Introduction

Thank you for purchasing this cable fault locator. Before attempting use of your new instrument please take the time to read this user guide, ultimately this will save you time, advise you of any precautions you need to take and could prevent damage to yourself and the instrument.

This is an advanced instrument capable of identifying a wide range of cable faults. The instrument uses a technique called Pulse Echo (also known as Time Domain Reflectometry or TDR). A pulse is launched into a cable from one end. This can be on either a pair of conductors, or a conductor and the screen. The cable's construction will determine its characteristic impedance and the velocity a pulse travels down the cable.

The pulse velocity is normally described as a fraction of the speed of light and is called the Velocity Factor. By measuring the time between the transmitted pulse and the reception of the reflected pulse, and multiplying this by the speed of light and the velocity factor, the actual distance to the reflection point can be established.

Reflections are caused by changes in the cable's characteristic impedance, such as poor joints or discontinuities. Faults showing impedance higher than that of the cables normal impedance will cause a reflection of the same polarity, i.e. positive, while faults with impedance lower than that of the cable will cause a negative going reflection. Matched cable terminations absorb all the pulse hence no "end of cable" reflection will occur, the cable appearing endless. Open or short circuits will reflect all the pulse and a large reflection will be displayed. At an open or short circuit all the transmitted energy is reflected and the TDR will not 'see' the cable beyond that fault.

As a pulse travels down a cable, the size and shape of that pulse is gradually attenuated by the cable. The pulse reduces in amplitude and becomes more elongated or stretched. The level of attenuation (or loss) is determined by the cable type, the condition of the cable and any connections along its length. The limit of how far you can see is determined by the point beyond which you will not be able to see or distinguish a reflection. To help identify small reflections, especially at greater distance the instrument has an adjustable gain setting. By increasing the gain small reflections become visible

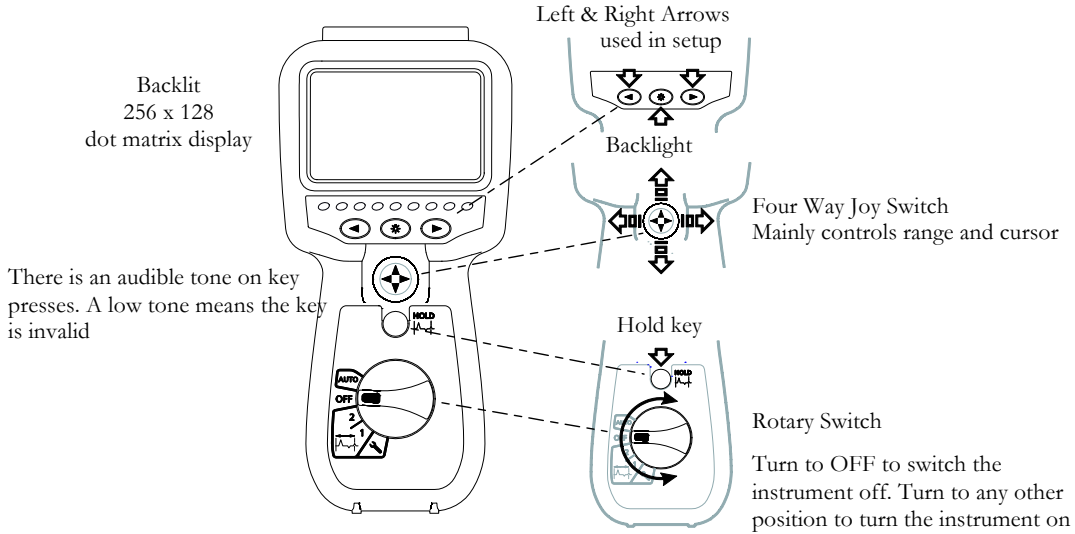
The velocity factor of the TDR must be adjusted to match that of the cable under test, allowing an accurate distance measurement to be read directly from the instrument. Where the VF of a cable is not known, but the length is, the cursor can be set to the end of the cable and the VF on the TDR adjusted until the correct cable length is displayed.

The instrument can be used on any cable consisting of at least two separate conductive elements, one of which may be the armouring or screen of the cable. It has internal matching networks to allow testing of 25 Ω, 50 Ω, 75 Ω and 100 Ω cables. (These typically correspond to power, coaxial data and data/telecoms cable). By selecting the TDR impedance closest to that of the cable under test, maximum power can be transmitted into the cable allowing long cables to be tested. If the impedance of the cable under test is unknown, the auto-impedance function may be used to determine the cable impedance and set-up the TDR automatically.

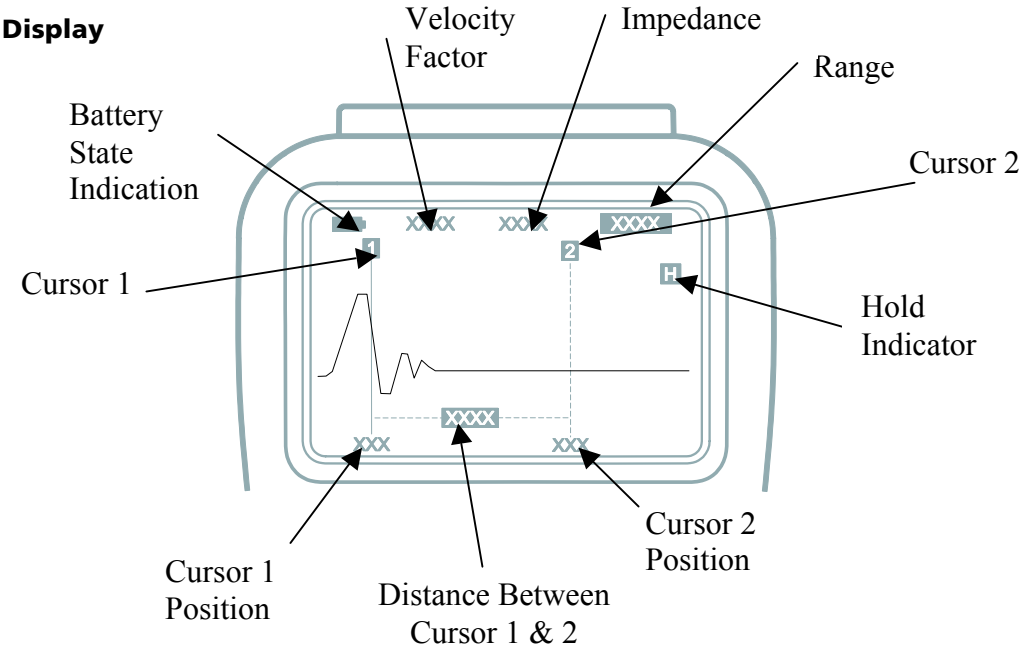
The distance units can be changed between metres and feet. Display contrast is automatically adjusted for temperature, but can be adjusted further for optimum display. A backlight aids viewing in low ambient light conditions.

The instrument can be powered by manganese alkali, or nickel-metal-hydride battery. All cells must be of the same type.

Overview
Instrument Layout & Display



Display

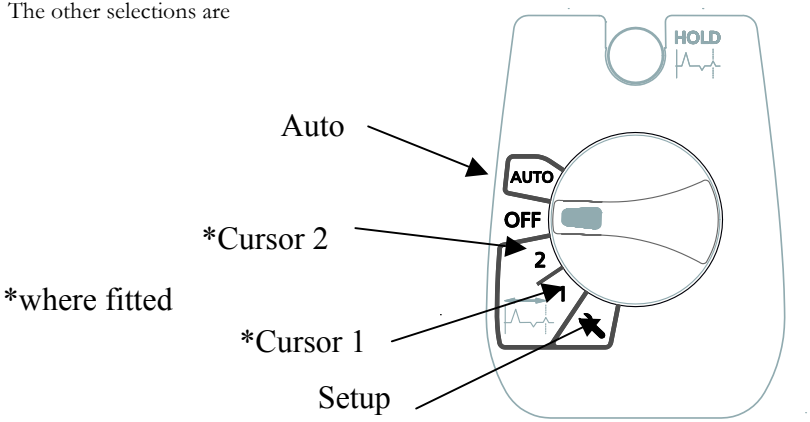

Velocity Factor
Impedance
Range
Battery State Indication
Cursor 2
Cursor 1
Hold Indicator
XXXX
XXX
XXX
XXXX
1
2
H
XXXX
XXX
XXX
Cursor 1 Position
Distance Between Cursor 1 & 2
Cursor 2 Position

Controls

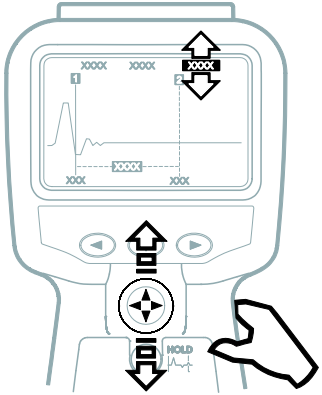
Rotary Switch

Turn the switch from OFF to another position to turn the instrument on. The instrument may be turned off, by switching to OFF, or the instrument may switch itself off if it has not been used for 5 minutes or the battery is exhausted.

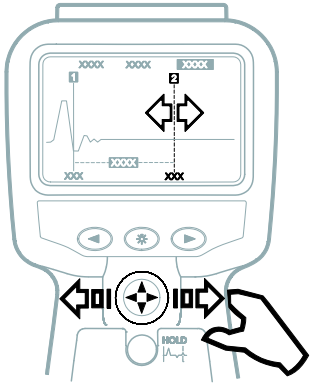
The other selections are



Range & Cursor Control

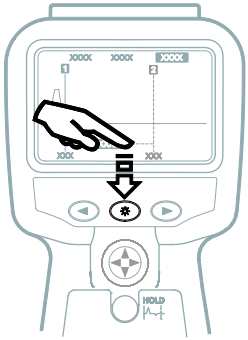


The range is set using the four way switch; press up to increase the range and down to reduce the range.

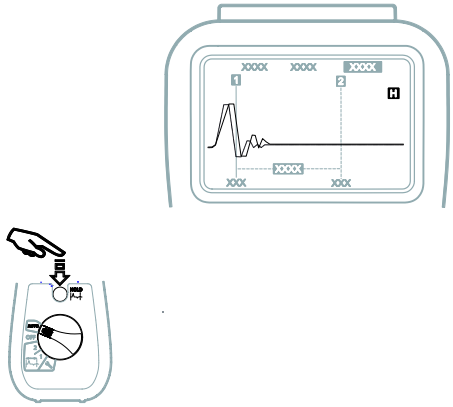


Moving the four-way switch left or right will move the active cursor.

Backlight & Hold



Backlight key. Press the backlight key to switch the backlight on. It will switch off after one minute with no key press when activated, or it may be switched off by pressing the key again

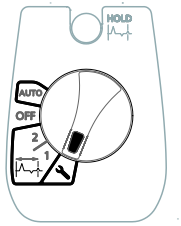


Hold key. When the rotary switch is set to cursor 1, cursor 2, or Auto, pressing the hold key will place an image of the current trace in grey on the display. This allows comparisons to be made between two cables or intermittent faults to be seen.

Setup

The setup position allows the Velocity Factor, Impedance, Pulse Width, Gain, Distance Units, Sound and Display Contrast to be set. These are remembered when the instrument is switched off and recalled when switched back on.

To adjust any of these parameters turn the rotary switch to the setup position. The parameter to be adjusted is highlighted at the top of the screen. Pressing the left or right key will select a different parameter; using the four-way joy switch will change the parameter.

	Velocity Factor	The velocity factor is a characteristic of the cable under test and needs to be set correctly for the distance to be accurate. Refer to the section in this user guide for further information.
	Impedance[1]	The impedance is a characteristic of the cable under test and needs to be set correctly for the best display. Refer to the section in this user guide for further information.
	Pulse Width[1]	The pulse width may be adjusted for a clearer display.
	Gain[1]	The gain may be adjusted for a clearer display
	Distance units	The distance may be shown in metres or feet.
	Contrast control	The display contrast may be adjusted.
	Sound	The instrument's sounder can be muted.

[1]While in Auto the unit will select the optimal impedance, pulse width and gain for the current range, overriding any manually set values. Whilst in Cursor 1 or Cursor 2 the unit will select a pulse width and gain for the current range, yet the user may override the selection.

Operation

General Testing procedure

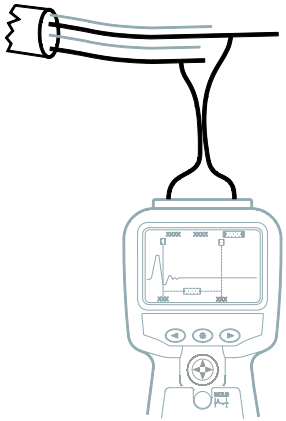
Ensure the correct test leads are firmly fitted into the sockets of the instrument.
Switch on the instrument. The instrument will display the start screen for a couple of seconds, followed by a trace. The instrument will remember the settings last used.

If necessary, adjust the display contrast and distance units to the preferred settings. Use the setup mode to set the velocity factor and impedance of the cable about to be tested. Refer to 'Velocity factor' later in this text for details.

Operating Modes

Auto	Impedance of cable under test, pulse width and gain automatically selected for chosen range. (Cable must be greater than 10m or 30 ft)
2	Adjust the position of Cursor 2. Manual adjustment of measurement range
1	Adjust the position of Cursor 1. Manual adjustment of measurement range
Setup	Manually select impedance, pulse width, gain, VF, mute, contrast, and distance units

Connection to Cable Under Test

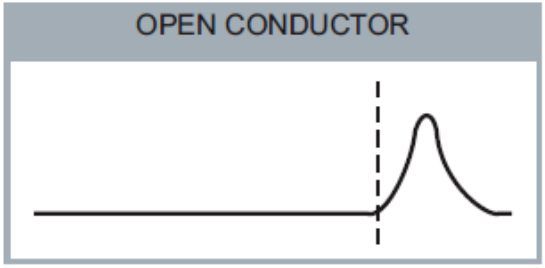


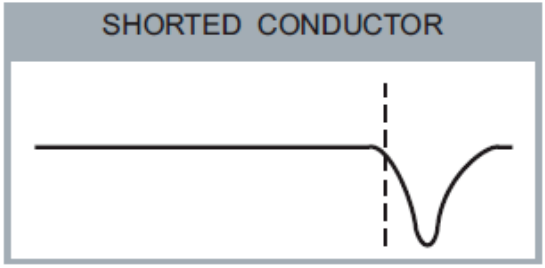
Connect the test lead to the cable under test. Connection may be made to a live power system with a voltage to earth (ground) less than 150 V with an installation (over voltage) category of I V or lower. This means that the instrument may be connected to any to primary supply circuits such as overhead cables. The voltage must be less than 300 V between the terminals and 150 V CAT IV to earth.

The fused lead set must be used to connect to power systems. Refer to the accessories section.

The 4mm plug to BNC adapter accessory is for use on cable distribution systems and low voltage cables only. The operator must verify that the circuit is safe for testing and take the appropriate precautions.

In the event of no reflections being visible, increase gain in setup mode until any reflection can be easily identified. (If no reflections can be seen, try shorting or earthing the far end of the cable to ensure that you are "seeing" the whole length of the cable).
The range may be changed by moving the four-way switch up and down and the cursor moved using the LEFT and RIGHT joy switch. Move the cursor to the beginning of the reflection. The distance to the fault can then be directly read from the display.
The distance calculation is performed using the velocity factor set in the TDR. If this velocity factor is not correct for the cable under test, the displayed distance will be incorrect.
Shown are two typical trace displays. The first shows an open circuit; the second a short circuit.





Velocity Factor

The velocity factor is used by the instrument to convert the measured time for a pulse to be reflected, into a distance. It is displayed as a ratio of the speed of light (eg 0.66 = 66% of the speed of light).

If the exact length of cable is known and the reflection from the cable end is visible then an accurate velocity factor can be determined:

- Locate the reflection caused by the end of the known length of cable with the instrument set on the shortest possible range to see the end of the cable.
- Locate the start of this reflection as described in the Operation section of this manual.
- Adjust the velocity factor until the correct cable length is shown.
- Note the VF value for future reference.

The measurement of the distance to the fault can now be made with more confidence. The ability of the instrument to accurately measure the distance to a cable feature relies on the velocity factor being correct. Any errors in the velocity factor are directly related to distance measurement errors.

Pulse Widths

As the range of the TDR is adjusted so the duration of the transmitted pulse changes. The pulse width range varies from 2 ns to overcome signal attenuation and enable the instrument to see further down a length of cable. The greater the range selected on the TDR, the wider the transmitted pulse.

The accuracy of the "distance to fault" is not affected by the length of the pulse. However, if two or more features exist close together (excluding open or short circuits), then the second or subsequent feature may be partially masked by the reflection from the first fault. Hence, for potential multiple features, the instrument should be used with the shortest suitable range, and also the smallest pulse width selected, that allows both features to be seen.

For output pulse characteristics, refer to output pulse data in the TDR Specification at the end of this guide.

Techniques

To improve on the accuracy of the measurement, numerous techniques can be used, depending on the situation encountered. Not every situation can be described, but the following points are effective and the most common and easily implemented methods.

Test the cable from both ends

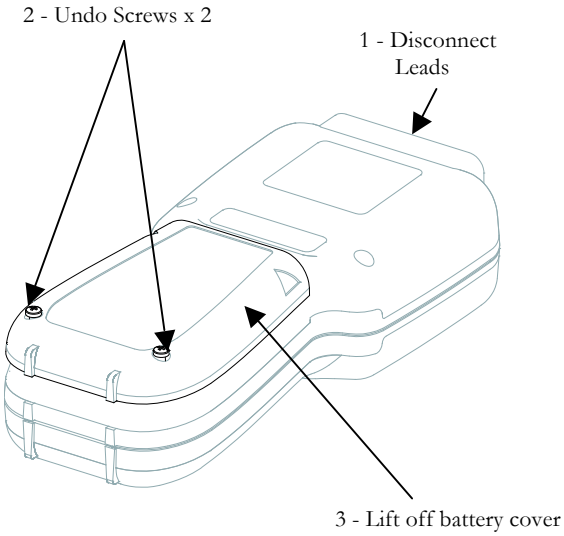
When fault finding on a cable it is good practice to take measurements from both ends, particularly in the case of open circuit faults, when the true end of the cable is not visible. If the measurement is made from both ends, then the combined answer should equal the expected length of the cable. Even when the true end of the cable is visible on the display, the reflections after the fault may be too obscure to analyze clearly. In this case, measurement from both ends yields a clearer picture as well as improved accuracy. It is also good practice to follow the cable route with a cable tracer, as not all cable runs will be straight. It can save a great deal of time if the exact route of the cable is known as faults are often found at these points and can be accredited to third party intervention.

Care and Maintenance

Other than replacing the batteries, the instrument has no user serviceable parts. In case of failure it should be returned to your supplier or an approved Megger repair agent.

Cleaning the instrument should only be done by wiping with a clean cloth dampened with soapy water or Isopropyl Alcohol (IPA).

Battery
Battery Replacement



- Switch off the instrument
- Disconnect the instrument from any electrical circuits
- Undo two screws
- Remove the battery cover from the base.
- For battery replacement:
  a) Remove old batteries
  b) Refit new batteries following correct polarity as marked on the battery holder
  c) Replace the battery cover
  d) Tighten Screws
  e) Do not mix old and new batteries

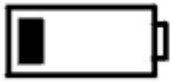
Incorrect battery cell polarity can cause electrolyte leakage, resulting in damage to the instrument.

Battery type: 5 x 1.5 V Alkaline LR6 (AA) or NiMH HR6 rechargeable.

The crossed out wheeled bin placed on the batteries is a reminder not to dispose of them with general waste at the end of their life. Alkaline and NiMH batteries are classified as portable batteries and must be disposed of in accordance with local regulations. For details contact your local distributor.

Battery Indicator

The battery state indicates how much life remains in the battery; the more black bars are shown, the longer the life remaining. Replace the battery when there are no bars showing.



Battery almost exhausted
(1 volt per cell)

Specifications

Except where otherwise stated, this specification applies at an ambient temperature of 20 ºC

General

Ranges:	10 m	25 m	100 m	250 m	1000 m	2500 m	5000 m
	30 ft	75 ft	300 ft	750 ft	3000 ft	7500 ft	15000 ft

Accuracy: ±1% of range ± pixel at 0.67VF
[Note- The measurement accuracy is for the indicated cursor position only and is conditional on the velocity factor being correct.]

Resolution: 1% of range

Output pulse: 5 volts nominal peak to peak into open circuit. Pulse widths determined by range and cable

Gain: Set for each range with three user selectable steps (in Manual operating mode)

Velocity Factor: Variable from 0.2 to 0.99 in steps of 0.01

Power Down: Automatic after 5 minutes with no key press

Backlight: Stays on for 1 minute with no key press when activated

Batteries: Five LR6 (AA) type batteries, Manganese alkali or nickel metal-hydride cells

Battery Life: 14 hours typical.

Safety
When using the Fused Test Lead Set this instrument complies with EN 61010-1 for connection to live systems with less than 300V between the terminals and 150V CATIV to earth. When using the Miniature clip Test Lead Set, Bed of Nails Test Lead Set or BNC Adapter the system is rated for safety low voltage systems only.

EMC
Complies with Electromagnetic Compatibility Specifications (Light industrial) BS EN 61326-1, with a minimum performance of 'B' for all immunity tests

Mechanical: The instrument is designed for use indoors or outdoors and is rated to IP54.

Case dimensions: 230 mm (9 in.) x 115 mm (4.5 in.) x 48 mm (2 in.)

Instrument weight: 0.6 kg (1.32 lbs)

Case material: ABS

Connectors: Two 4 mm-safety terminals

Display: 256 x 128 pixel Graphics LCD

Environmental
Operational temperature: -15 ºC to +50 ºC (5 ºF to 122 ºF)
Storage temperature: -20 ºC to 70 ºC (-4 ºF to 158 ºF)

Waste electrical and electronic equipment

WEEE

The crossed out wheeled bin placed on Megger products is a reminder not to dispose of the product at the end of its life with general waste.

Megger is registered in the UK as a producer of electrical and electronic equipment. The Registration Number is WEE/HE0146QT.

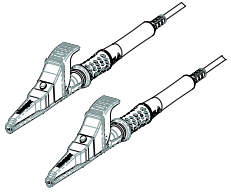
Megger is registered in the UK as a producer of batteries. The Registration Number is BPRN00142.

Ordering Information

Item	Order No.
TDR1000/3 Time Domain Reflectometer includes Miniature clip test lead set	1001-788
TDR1000/3P Time Domain Reflectometer includes fused test lead set	1001-789
CFL510G Time Domain Reflectometer includes Bed of Nails test lead set and BNC adapter	1001-790
Accessories	
User information CD	2002-178
Hard carry case	5410-420
Miniature clip test lead set	6231-652
Bed of nails test lead set	6231-653
Fused test lead set	1002-015
BNC adapter	25965-154

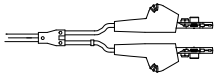
Test Lead selection

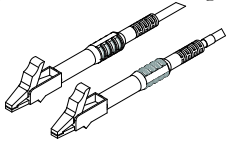
Fused test lead set
Megger Part Number 1001-717

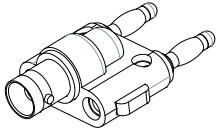


must be used on power systems

Other test leads and the BNC adapter **must** only be used on low voltage systems







Repair and Warranty

The instrument contains static sensitive devices, and care must be taken in handling the printed circuit board. If an instrument's protection has been impaired it should not be used, but sent for repair by suitably trained and qualified personnel. The protection is likely to be impaired if for example, it shows visible damage, fails to perform the intended measurements, has been subjected to prolonged storage under unfavourable conditions, or has been subjected to severe transport stresses.

FOR INSTRUMENT WARRANTY DETAILS PLEASE REFER TO WARRANTY CARD SUPPLIED WITH INSTRUMENT.

Note: Any unauthorized prior repair or adjustment will automatically invalidate the Warranty.

CALIBRATION, REPAIR AND SPARE PARTS

For service requirements for Megger Instruments contact:

Megger Limited
Archcliffe Road
Dover
Kent CT17 9EN
England.
Tel: +44 (0) 1304 502 243
Fax: +44 (0) 1304 207 342

Megger operate fully traceable calibration and repair facilities, ensuring your instrument continues to provide the high standard of performance and workmanship you expect. These facilities are complemented by a worldwide network of approved repair and calibration companies to offer excellent in-service care for your Megger products.

Approved Service Centres

A list of Approved Service Centres may be obtained from the UK address above, or from Megger's website at www.megger.com

Returning your product to Megger - UK and USA service centres

1. When an instrument requires calibration, or in the event of a repair being necessary, a Returns Authorisation (RA) number must first be obtained from one of the addresses shown on the following page. You will be asked to provide the following information to enable the Service Department to prepare in advance for receipt of your instrument, and to provide the best possible service to you.
    - Model, e.g. TDR1000/3
    - Serial number, to be found on the underside of the case or on the calibration certificate.
    - Reason for return, e.g. calibration required, or repair.
    - Details of the fault if the instrument is to be repaired.
2. Make a note of the RA number. A returns label can be emailed or faxed to you if you wish.
3. Pack the instrument carefully to prevent damage in transit.
4. Ensure the returns label is attached, or that the RA number is clearly marked on the outside of the package and on any correspondence, before sending the instrument, freight paid, to Megger. Copies of the original purchase invoice and packing note should be sent simultaneously by airmail to expedite clearance through customs. In the case of instruments requiring repair outside the warranty period, an immediate quotation can be provided when obtaining the RA number.
5. You may track the progress of your return on line at www.megger.com